
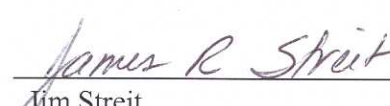
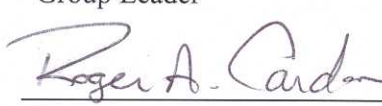

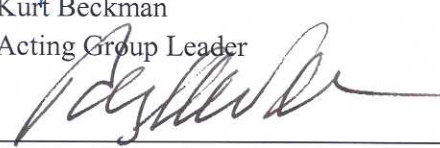


CRITERION 729

HIGH EXPANSION FOAM SUPPRESSION

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RECORD OF REVISIONS

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CRITERION 729

HIGH EXPANSION FOAM SUPPRESSION

1.0 PURPOSE

The purpose of this Criterion is to establish the minimum requirements and best practices for operation and maintenance of high expansion foam fire suppression systems at LANL.

This document addresses the requirements of LIR 230-05-01(Ref 10.1), "Operations and Maintenance Manual."

Implementation of this Criterion satisfies DOE Order 430.1A (Ref 10.2) for the subject equipment/system. DOE Order 430.1A (Ref 10.2) "Life Cycle Asset Management," Attachment 2 "Contractor Requirements Document," Paragraph 2, Sections A through C, which in part requires UC to "...maintain physical assets in a condition suitable for their intended purpose," and employ "preventive, predictive, and corrective maintenance to ensure physical asset availability for planned use and/or proper disposition." Compliance with DOE Order 430.1A is required by Appendix G of the UC Contract.

2.0 SCOPE

The scope of this Criterion includes the routine inspection, testing and preventive and predictive maintenance of high expansion foam fire suppression systems. This Criterion does not address corrective maintenance actions required to repair or replace equipment.

LANL currently has one operational high expansion foam suppression system, employing a fire booster pump, venturi pick up tube and eductor proportioning components. If additional systems employing other proportioning technology are installed at LANL, this Criterion will require revision to capture additional requirements.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

CFR	Code of Federal Regulations
DOE	Department of Energy

FWO	Facility and Waste Operations
ITM	Inspections, Testing, and Maintenance
LIR	Laboratory Implementing Requirement
LPR	Laboratory Performance Requirement
O&M	Operations and Maintenance
MSE	Maintenance and Systems Engineering
PP&PE	Personal Property and Programmatic Equipment
RP&IE	Real Property and Installed Equipment
SSC	Structures, Systems, and Components
SSS	Support Services Subcontractors
UC	University of California

3.2 Definitions

Eductor. A device that uses the venturi principle to introduce a proportionate quantity of foam concentrate into a water stream. The pressure at the throat is below atmospheric pressure and will draw in liquid from atmospheric storage.

Foam Concentrate. Concentrated liquid foaming agent as received from the manufacturer. An example is Ansul/Jet-X high expansion foam concentrate.

Foam Solution-A homogeneous mixture of water and foam concentrate in the proper proportion.

Foam Suppression Systems-Foams are aggregations of bubbles that are mechanically generated by the passage of air or other gases through a net, screen, or other porous medium that is wetted by an aqueous solution of surface active foaming agents. Under proper conditions, fire-fighting foams of expansions from 200:1 to 1000:1 can be generated. These foams provide a unique agent for transporting water to inaccessible places; for total flooding of confined spaces; and for volumetric displacement of vapor, heat and smoke.

High Expansion Foam-An aggregation of bubbles resulting from the mechanical expansion of a foam solution by air or other gases with a foam-to-solution volume ratio ranging from 200:1 to approximately 1000:1.

Management Level Determination (ML1, ML2, ML3, ML4). A classification system for determining the degree of management control applied to facility work. See LIR 230-01-02 for definitions of each ML level.

Venturi. A tapered constriction in a pipe where fluid velocity increases and pressure decreases, thereby creating a suction at any opening into the side of the tube.

4.0 RESPONSIBILITIES

4.1 FWO-Maintenance and Systems Engineering (MSE)

- 4.1.1** FWO-MSE is responsible for the administrative content of this Criterion and monitoring the applicability and the implementation status of this Criterion and either assisting the organizations that are not applying or meeting the implementation expectations contained herein or elevating their concerns to the director(s).

Basis: LIR 301-00-01.11; Issuing and Managing Laboratory Operations Implementation Requirements and Guidance, Section 5.4, OIC Implementation Requirements.

- 4.1.2** FWO-MSE shall provide technical assistance to support implementation of this Criterion.

4.2 FWO-Fire Protection (FWO-FIRE)

- 4.2.1** FWO-FIRE is responsible for the technical content of this Criterion and monitoring the proper implementation across the Laboratory.
- 4.2.2** FWO-FIRE shall provide technical assistance to support implementation of this Criterion.

4.3 Facility Manager

- 4.3.1** Responsible for operations and maintenance of institutional, or Real Property and Installed Equipment (RP&IE) under their jurisdiction, in accordance with the requirements of this document.
- 4.3.2** Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document that may be assigned to the FM in accordance with the FMU-specific Facility/Tenant Agreement.

4.4 Group Leader

- 4.4.1** Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document, which are under their jurisdiction.
- 4.4.2** Responsible for system performance analysis and subsequent replacement or refurbishment of assigned PP&PE.

4.5 Authority Having Jurisdiction (AHJ) – Fire Marshal

- 4.5.1** The AHJ is responsible for providing a decision on specific technical questions regarding this Criterion.
- 4.5.2** The LANL Fire Marshal is the approval authority for all exceptions and variances to this Criterion.

4.6 Support Services Subcontractor (SSS)

- 4.6.1** Responsible for providing ITM of the fire protection systems addressed in this Criterion at the request of the responsible Facility Manager.
- 4.6.2** Responsible for coordinating work with the operating group and Facility Manager to conduct ITM in the affected area.

5.0 PRECAUTIONS AND LIMITATIONS**5.1 Precautions**

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. A compilation of all applicable precautions shall be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards/precautions that may not be immediately obvious.

- 5.1.1** LANL currently has one operational high expansion foam suppression system, employing a fire booster pump, venturi pick up tube and eductor proportioning components. If additional systems employing other proportioning technology are installed at LANL, this Criterion will require revision to capture additional requirements.

5.2 Limitations

The intent of this Criterion is to identify the minimum generic requirements and recommendations for SSC operation and maintenance across the Laboratory. Each user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, vendor O&M requirements and guidance, etc.).

Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities shall implement the requirements of DOE Order 433.1 (Ref. 10.3) as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations

for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or CFR identified above.

6.0 REQUIREMENTS

Minimum requirements that Criterion users shall follow are specified in this section. Requested variances and exceptions to these requirements shall be prepared and submitted to FWO-MSE in accordance with LIR 301-00-02 (Ref. 10.4), "Variances and Exceptions to Laboratory Operations Requirements," for review and approval. The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this analysis. Laws, codes, contractual requirements, engineering judgement, safety matters, and operations and maintenance experience drive the requirements contained in this section. Variances and exceptions to this Criterion shall be approved by the LANL Fire Marshal.

6.1 Operations Requirements

6.1.1 Operability Checklist

High expansion foam suppression systems must remain in service at all times. A system shall be deemed operable when the following conditions are met:

- The appropriate portion of the foam system piping is filled with water,
- The system water control valve is in the required position,
- Fire detection and alarm system is operable (Criterion 720),
- The water flow alarm is operable,
- Fire pumps, including booster pumps, are operable (Criterion 723)
- Foam discharging devices are not obstructed,
- Air supplies to foam discharging devices are not obstructed,
- Piping, fittings, hangers, foam discharging devices, foam generators, foam eductors/proportioners, valves, backflow preventers, pumps, and other components are in their proper locations and in good repair,
- There is an adequate supply of water flow and pressure available from the water system to supply the foam system at its required minimum design conditions,
- Foam concentrate storage tanks are full to within the manufacturer's specifications, and contain the required foam concentrate (container label vs. system design documentation),
- Foam concentrate is not past its shelf life,

- Foam eductors/proportioners are in-place and in good repair, and
- Reserve supply of foam concentrate is reliably available with 24 hours to return the system back to service following activation.

Basis: NFPA 11A, 1999 Standard Edition for High Expansion Foam Systems § 1-13, and NFPA 25, 2002 Standard Edition for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.1.2 Daily Inspections

Valve enclosure heating equipment, for valves subject to freezing, shall be inspected DAILY during cold weather for its ability to maintain a minimum temperature of at least 4 degrees C (40 degrees F).

EXCEPTION: Where riser enclosures are equipped with remotely-monitored low temperature alarms, visually inspect riser enclosure heating equipment WEEKLY.

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems, Chapter 12. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.1.3 Weekly Inspection

- Foam concentrate pump(s), storage tank(s), and piping are visually checked for leaks or damage
- Foam concentrate level in storage tank(s) normal,
- Manually operated shut-off valves correctly positioned and secured
- System control panel lights properly illuminated and in normal status
- Water supply pressure within normal range
- Battery systems operational and fully-charged
- All supervised functions verified for proper operation
- Water supply system and foam concentrates protected from freezing conditions (protected from temperatures < 40°F).

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems §'s 1-12, 1-13 and A-1-13. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.1.4 Monthly Inspections

Foam concentrate proportioning system is visually inspected, including the following:

- Strainers for external damage, leaking and corrosion
- Foam concentrate storage tank for external corrosion.

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems, Chapter 11. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.1.5 Quarterly Inspections

- Above ground piping, fittings, hangers, braces, equipment supports, strainers, pumps, and tanks are inspected for mechanical damage, leaking, corrosion, misalignment and general condition, including:
 - a) Mechanical damage (e.g., broken piping or cracked fittings)
 - b) External conditions (e.g., missing or damaged paint or coatings, rust and corrosion)
 - c) Secure attachment to structural supports and piping
 - d) Damaged or missing hangers and bracing
 - e) Misalignment or trapped sections, proper drainage pitch
 - f) Low point drains (automatic or manual) leaking
 - g) Condition of rubber-gasketed fittings

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems, Chapter 11. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.1.6 Semi-Annual Inspection(s)

- a) Visually inspect the system for its hydraulic nameplate, if provided, to ensure that it is securely attached and legible.

NOTE: The nameplate will contain hydraulic calculation information applicable to the foam suppression system.

- b) Visually inspect system valves, alarm devices, water flow devices, and gauges. Valves, alarm devices, water-flow devices, and gauges shall be

- c) visually inspected to verify that they are free of physical damage. Valves shall also be verified to be in their proper position. Visually inspect Fire Department Connections (FDCs) to verify the following:
- FDCs are visible and accessible
 - Couplings or swivels are undamaged and rotate smoothly
 - Plugs and caps are in place and undamaged,
 - Interior of the connection is unobstructed and valve clapper is operational over its full range when the FDC is plugged or if caps are out of place
 - Gaskets are in place and in good condition
 - Identification signs are in place
 - Check valve is not leaking
 - The automatic drain valve is in place and operating properly
 - Components are cleaned, repaired, or replaced as necessary in accordance with the manufacturer's instructions, and
 - FDC clapper(s) is in place and operating smoothly.

Basis: Equivalency to NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, Table 5.1

- c) Visually inspect system valves to ensure the following:
- Valves are in the correct position (normally open),
 - Valves are locked or supervised,
 - Valves are accessible,
 - Valves are free from external leaks,
 - Valves have appropriate identification, and
 - Manual-actuating valves are in the correct (normally closed) position.
- d) Inspect gauges to ensure that:
- Gauges have up-to-date calibration, and
 - Normal supply-side pressure is maintained.

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, Chapters 5 and 12.

6.1.7 Annual Inspections

- Inspect foam concentrate to ensure that quantity of agent meets design requirements and tanks or containers are at the required level, with adequate space for expansion.

- Inspect foam producing equipment including foam eductors, proportioning devices and associated equipment for general condition.
- Inspect fixed foam generators, including obstructions to discharge.
- Inspect strainers for general condition.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems § 1-13. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.1.8 5-Year Inspection

- Internally inspect all check valves to verify components operate properly, move freely, and are in good condition. Clean, repair or replace the internal components as necessary in accordance with the manufacturer's instructions.
- Internally inspect strainers, filters, and restricted openings every 5 years, unless tests indicate that a more stringent frequency is required.

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-base Fire Protection Systems, Chapters 5 and 12.

6.1.9 Other System/Component Inspections

- Fire detection and alarm systems integral to high expansion foam suppression systems should be inspected in accordance with Criterion 720.
- Fire pumps (including booster pumps) integral to high expansion foam suppression systems shall be inspected in accordance with Criterion 723
- Backflow preventers installed on water supplies to high expansion foam systems shall be inspected in accordance with Criterion 406.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems, NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems and NFPA 72, 1999 National Fire Alarm Code. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.2 Maintenance Requirements

Ensure all system components are working. Repair or replace any components that fail a test or inspection in accordance with manufacturer's instructions.

6.2.1 Annual Maintenance

- Perform a maintenance inspection of the foam concentrate and its storage tank/container. Replace concentrate if excessive sludging or deterioration is identified.

- If necessary to prevent concentrate build-up, flush the foam concentrate pump.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems § 1-13 and NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, Chapter 11. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.2.2 10-Year Maintenance

- Foam concentrate storage tank shall be drained and flushed (foam concentrate shall be permitted to be salvaged and re-used).
- Perform an internal and external maintenance inspection of the foam concentrate storage tank for corrosion.
- Foam concentrate pick-up pipes/lines hoses inside the foam concentrate storage tank shall be maintenance inspected for corrosion, separation or plugging.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems and NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.2.3 Other Maintenance Time Frames

- System strainers shall be removed, inspected and cleaned after each use (i.e., whenever water is run through the strainers).

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems, Chapter 11. Compliance with this code is required per Appendix G of the UC contract.

6.2.4 Other System/Component Maintenance

- Fire detection and alarm systems integral to high expansion foam suppression systems shall be maintained per Criterion 720.
- Fire pumps (including booster pumps) integral shall be maintained per Criterion 723.
- Backflow preventer shall be maintained per Criterion 406.

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, Chapter 11. Compliance with this code is required per Appendix G of the UC contract.

6.2.5 System Documentation

Post operating instructions and maintenance instructions and layouts at control equipment with a second copy on file.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems, Chapter 11. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.2.6 Training

All persons who are expected to inspect, test, maintain, or operate foam-generating apparatus shall be thoroughly trained and training shall be kept current over time.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems, Chapter 11. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.3 Testing Requirements**6.3.1 Semi-Annual Testing (twice per year)**

- Test the system alarms by using the alarm bypass connection.
- Test control valve supervisory switches.
- Conduct a main drain test.

Basis: NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, Chapter 12. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.3.2 Annual Testing

- High expansion foam systems shall be thoroughly tested for proper operation.
- Automatic and manual activation means shall be tested for proper operation and system activation.
- Full foam discharge tests shall be made where any inspection indicates its advisability.
- Test foam concentrate quality of both the in-service and reserve agent to determine whether any changes in physical properties have occurred indicating deterioration of performance.
- During the foam discharge test, a sample of the foam shall be taken to verify proper eductor/proportioner operation. The foam sample shall be checked by refractometric or conductivity testing to verify foam concentration in the solution (see NFPA 11, Appendix C for details)

performing these tests). Concentrate of foam shall be within 10% of the acceptance test results or design concentration.

- Fully close and reopen the system control valve(s).

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam § 1-13 and NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems, Chapters 11 and 12. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.3.3 Other System/Components Testing

- Every 5 years, replace gauges or test by comparison to a calibrated gauge and adjust to bring into acceptable condition.
- Fire detection and alarm systems integral to high expansion foam suppression systems, including auxiliary functions controlled and/or monitored by the fire alarm control essential for suppression system performance such as door closers, power shunt trips, dampers, etc., shall be tested in accordance with Criterion 720.
- Fire pumps (including booster pumps) integral to high expansion foam suppression systems shall be tested in accordance with Criterion 723.
- Backflow preventers installed on water supplies to high expansion foam systems shall be routinely tested in accordance with Criterion 406.

Basis: NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems, NFPA 25, 2002 Edition Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems and NFPA 72, 1999 National Fire Alarm Code. Compliance with this NFPA code is required per Appendix G of the UC contract.

6.4 Impairments

6.4.1 If one or more of the operability requirements listed in Section 6.1.1 are not maintained, follow the actions outlined in Criterion 733, Fire Protection System Impairment Control Program.

6.4.2 Inspection Following Impairment

Inspect affected portion of foam system prior to its return to service. Refer to Section 6.1.1 and 6.1.2 of this Criterion for guidance.

6.4.3 Testing Following Impairment

- Check water supply to verify an adequate pressure and volume of water is available at the system connection.
- Check the position of water supply control valve(s).

- Test all affected aspects of system operation prior to its return to service, including local alarms and alarm transmission to the Central Alarm Station.
- Perform hydrostatic test of affected system piping in accordance with NFPA 11A if piping pressure boundary has been breached.
- Verify quality and level of foam concentrate if the system has been out of service for 6 months or more.

7.0 RECOMMENDATIONS AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on his/her unique application and operating history of the subject systems/equipment.

7.1 Operations Recommendations

7.1.1 Persons other than SSS Fire Protection Maintenance personnel may conduct visual inspections identified in this document.

7.1.2 Operational testing and alarm verification will be conducted by SSS personnel, in compliance with LIR 402-910-01, Section 6.0.

7.2 Maintenance Recommendations

7.2.1 There are no recommendations for this Criterion.

8.0 GUIDANCE

8.1 Operations Guidance

8.1.1 Not applicable.

8.2 Maintenance Guidance

8.2.1 Not applicable.

9.0 REQUIRED DOCUMENTATION

Maintenance history shall be maintained for high expansion foam suppression systems to include, as a minimum, the parameters listed in the Table 9-1 below:

Table 9-1 Documentation Parameters

MAINTENANCE HISTORY DOCUMENTATION PARAMETERS				
PARAMETER	ML 1	ML 2	ML 3	ML 4
System Maintenance Activities				
Repair / Adjustments	X	X	X	X
PM Activities	X	X	X	X
System Equipment Problems				
Failure Dates	X	X	X	X
Failure Root Cause	X	X	X	X
System Inspection Results				
Inspection Date	X	X	X	X
SSC Condition	X	X	X	X

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of LPR 230-07-00, Criteria 2, (Ref. 10.5) which states; “Maintenance activities, equipment problems, and inspection and test results are documented.”

10.0 REFERENCES

The following references, and associated revisions, were used in the development of this document.

- 10.1** LIR 230-05-01.0, Operation and Maintenance Manual.
- 10.2** DOE O 430.1A, Attachment 2 “Contractor Requirements Document” (Paragraph 2, Sections A through C), a requirement of Appendix G of the UC Contract.
- 10.3** DOE Order 433.1, Maintenance Management Program for DOE Nuclear Facilities.
- 10.4** LIR 301-00-02.0, Variances and Exceptions to Laboratory Operation Requirements.
- 10.5** LPR 230-07-00, Maintenance History, Performance Criteria [2].

Criterion 729: High Expansion Foam Suppression

Date: 07/16/03

Revision 0

- 10.6** NFPA 11A, 1999 Edition Standard for High Expansion Foam Systems
- 10.7** NFPA 25, 2002 Edition Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems
- 10.8** NFPA 72, 1999 National Fire Alarm Code
- 11.0** **APPENDICES**
Not applicable.